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(54) **Heating apparatus.**

(57) A heating unit includes two tubular tungsten-halogen lamps (1, 2), each having a tungsten filament (3, 4). The lamps (1, 2) are supported within a ring (7) of ceramic fibre material and the unit is preferably mounted beneath an infra-red-transmissive cooktop to define a hotplate area (8) of a cooking hob. A control circuit provides a range of discrete power outputs of the lamps (1, 2), each power output corresponding to a power control setting set by a user of the cooking hob. The circuit includes a phase control circuit (19) for switching power to the lamps (1, 2) at a predetermined phase angle to achieve one or more of the lower power outputs.

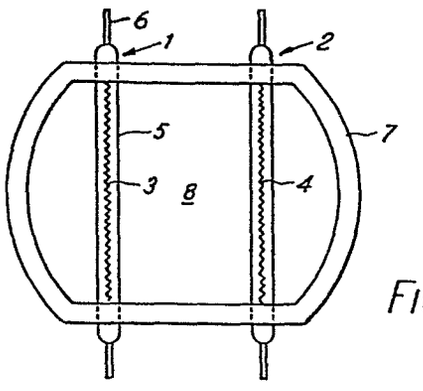

FIG.1

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HEATING APPARATUS

This invention relates to heating apparatus and in particular, though not exclusively, to such apparatus incorporating one or more sources of infra-red radiation, as disclosed in our copending U.K. Patent Application No.8320717 (Publication No.2132060A).

The heating apparatus disclosed in 8320717 includes, in one embodiment, four infra-red-emitting, tungsten-halogen lamps arranged in a heating unit, which is disposed beneath an infra-red-transmissive, glass ceramic layer to form a hotplate area of a cooking hob. The tungsten filaments of the lamps are switched in various series and/or parallel configurations to achieve a range of discrete power outputs providing a suitable temperature control of the hotplate. A diode is also arranged to be connected into one or more of the lamp configurations to achieve the lower power outputs.

However, a smaller hotplate, using less than four lamps in one heating unit, may be desirable, in which case fewer lamp configurations, and thus power outputs, would be possible to achieve. In particular, relatively low power outputs, which are generally required for simmering purposes would not be available using known switching techniques.

It is therefore an object of the present invention to provide heating apparatus of the above-mentioned type, which is capable of achieving a wider range of discrete power outputs than hitherto.

According to the present invention there is provided heating apparatus including a number of sources of infra-red radiation and a control circuit for providing a number of discrete power outputs of said sources, and characterised in that said control circuit includes means for switching power to said sources at a predetermined phase angle to achieve one or more of said power outputs.

Preferably the sources of infra-red radiation each comprises a tungsten filament supported in a quartz envelope, and the control circuit is arranged to switch the filaments into series and/or parallel configurations to achieve each of the discrete power outputs.

The means for switching power to said sources at a predetermined phase angle may be connected into one or more of the filament configurations to increase the range of available power outputs, and in particular to achieve relatively low power outputs.

The present invention may be used to provide a dual control arrangement of a heating unit comprising, for example, four infra-red lamps, wherein a wide range of power outputs may be achieved from two inner-positioned lamps, which are energisable independently of the two outer-positioned lamps.

The lamps may also be configured into a curved shape to provide efficient illumination of the whole area of the heating unit with as few as two lamps.

The invention will now be further described by way of example only with reference to the accompanying drawings, wherein:-

Figure 1 shows one embodiment of the present invention,

Figure 2 shows a control circuit for the embodiment in Figure 1,

Figure 3 shows a table of the range of power outputs provided by the circuit in Figure 2,

Figure 4 shows a second embodiment of the invention,

Figure 5 shows a control circuit for the second embodiment,

Figure 6 shows a table of the range of power outputs provided by the circuit in Figure 5,

Figure 7 shows an alternative embodiment to that shown in Figure 1, and

Figure 8 shows a cross-sectional view of a modified infra-red lamp, which may be incorporated in the present invention.

Figure 1 shows a heating unit including two tubular infra-red-emitting, tungsten-halogen lamps 1 and 2, each having a tungsten filament, 3 and 4, respectively supported within a quartz envelope, such as 5. Each end of each lamp 1, 2 is provided with a pinch seal, such as 6, having an electrical connection to the filament sealed therein. The lamps 1, 2 are supported within a ring of ceramic fibre material 7, and the unit is preferably mounted beneath a cooktop of infra-red-transmissive material, such as glass ceramic (not shown), so as to define a hotplate area 8 of a cooking hob.

The lamps 1, 2 and the ceramic fibre material 7 are preferably mounted above a supportive, shallow, metallic tray (not shown in Figure 1), containing a layer of thermally-insulative and reflective material (also not shown in Figure 1) as disclosed in our copending U.K. Patent Application No.8320717 (Publication No.2132060A).

Figure 2 shows a control circuit for providing a range of discrete power outputs of the lamps 1, 2, each power output corresponding to a power control setting number, as shown in Figure 3, set by a user of the cooking hob. The control circuit includes eight switches 9 to 16, inclusive, which provide six discrete power outputs of the lamps 1, 2 by selectively closing a number of the switches. Series and/or parallel lamp configurations, each producing a particular power output, are also shown in Figure 3, and it can be seen that, in two of the configurations, one or more diodes are also required to achieve the desired power output. The diodes are shown at 17 and 18 in the circuit in Figure 2 and can be switched into the lamp configurations when required.

However, use of series and/or parallel la[illegible]urations and diodes are not sufficient to achieve the two lowest power outputs of approximately 150W and 110W, respectively, which are generally required for simmering purposes, and to this end, the present invention provides a phase control circuit 19, which may also be switched into one or more of the lamp configurations by closure of the switch 10. The circuit 19 includes a diac 20 and a triac 21, the conducting time of which is determined by a capacitor 22 and resistors 23, 24. By selecting either resistor 23 or resistors 23 and 24, via switch 9, a predetermined phase angle is generated by the phase control circuit 19, which thus changes the power output. So that, for setting No.2, switches 9 and 10 are closed to produce a first predetermined phase angle, which achieves a power output of approximately 150W, and for setting No.1, switch 9 is open and switch 10 is closed to produce a second predetermined phase angle, which achieves a power output of approximately 110W. Switch 25 and resistor 26, shown in dotted lines, may be used to provide a third predetermined phase angle, which achieves a power output of approximately 200W, and may thus be employed as an alternative to setting No.3 as shown in Figure 3.

The heating unit shown in Figure 1 preferably has a diameter of approximately 155mm and each of the lamps 1, 2 preferably has a filament length of 128mm with a power output of 600W.

However, any alternative power outputs of the lamps may of course be utilised, such as 900W, for example, in which case the maximum combined output would be 1800W and the lower outputs would be proportionally higher than those shown in Figure 3.

Figure 4 shows an alternative embodiment of the invention, wherein two inner lamps 27, 28 and two outer lamps 29, 30 are provided, each of the lamps 27 to 30, having a tungsten filament 31 to 34, respectively, are supported in ceramic fibre material 35.

By employing a phase control circuit, as shown at 19 in Figure 2, the two inner lamps 27, 28 may be energised

independently of the two outer lamps 29, 30, thereby providing a dual-ring hotplate, wherein either only central region 36 or whole hotplate area 37 may be heated by the lamps.

Figure 5 shows a control circuit including eleven switches 38 to 48, inclusive, two diodes 49, 50 and a phase control circuit denoted schematically by triac 51. By selectively closing the switches 38 to 48, five settings 1I to 5I can be achieved for the central region 36 with only inner lamps 31, 32 energised, and six settings 1D to 6D can be achieved for the whole hotplate area 37 with all four lamps 31 to 34 energised. It can be seen that the phase control circuit 51 is required to achieve the lowest setting 1I to produce a power output of approximately 116W, which is suitable for simmering purposes.

The phase control circuit 51 may, in fact, be employed in any lamp configuration, shown in Figure 6, which produces a power output of up to 340W.

For the embodiment shown in Figure 4, the diameter of the central region 36 is preferably approximately 125mm and the whole hotplate area 37 is preferably approximately 200mm. The inner lamps 27, 28 preferably each have a power output of 500W with a filament length of 117mm and the two outer lamps 29, 30 preferably each have a power output of 600W with a filament length of 145mm.

It can thus be seen that by use of the phase control circuit in one or more of the lamp configurations, relatively low power outputs can be achieved with a minimum number of two infra-red lamps, thereby enabling smaller hotplate areas, as well as dual-ring hotplates, to be provided in a cooking hob incorporating such lamps.

Another heating unit, in accordance with the present invention, is shown in Figure 7 in more detail than the units shown in Figures 1 and 4.

In Figure 7, a generally circular shallow tray 60, preferably made of metal, has disposed therewithin, on the base thereof, a layer 61 of thermally-insulative material, which may be fabricated from a microporous material, for example that

known as Microtherm. The tray 60 has two extending flanges, 62 and 63, arranged on opposite sides of the rim of the tray 1, each flange having upturned end portions, 64 and 65 respectively.

Two tungsten-halogen lamps (one being shown at 66) are disposed above the layer 61 of insulative material and are supported at each end by the flanges, 62 and 63.

A moulding 67 of ceramic fibre material is disposed above the tray 1 and press-fitted around the ends of each lamp 66 to provide a suitable packing therefor.

Each lamp 66 has moulded ceramic end caps, one shown at 68, enclosing each pinch-seal (not shown) and being provided with a location tab 69, so that the lamps can easily be inserted in gaps provided in the upturned portions 64 and 65, on the flanges 62 and 63.

The tray 60 and flanges 62 and 63 are preferably made of metallic material and sufficient clearance is allowed in each gap provided for the end caps 68 to permit expansion of tray and flanges without breaking the lamps, whilst providing sufficient support for the lamps during attachment of electrical wiring to the amp tag connectors. It also permits conduction of heat away from the lamp pinch-seals via the flange to maintain satisfactory operating temperatures. Heat is also conducted away from the lamp ends by way of the electrical wiring attached thereto.

The ceramic fibre moulding 67 is also sufficiently flexible to allow a certain amount of movement, caused by expansion and contraction of the tray and/or flanges whilst providing positive location for the lamps.

As described above in connection with Figure 1, a number (e.g. two or four) of the heating units shown in Figure 7 are disposed below a layer of glass ceramic, which is in this example fabricated from Corning Black Cooktop 9632, to provide a slimline cooking hob, which may be of depth comparable with that of a standard worktop.

A thermal limiter 70, which is intended to limit the operating temperature of the glass ceramic layer, comprises a

metallic rod encased in a sheath of quartz and arranged so as to operate a microswitch 71. The limiter is, in this example, provided between the lamps 66 and the layer of insulative material (though it may be located elsewhere) and is adjusted so that expansion of the rod, due to heat emitted by the lamps, causes one end of the rod to operate the microswitch 71 when the temperature has reached a threshold value, thereby disconnecting the power to the lamps. Steps are preferably taken to render the limiter more responsive to thermal emission from the cooktop than to directly emitted, or reflected, radiation of the wavelengths emitted by the lamps.

It has been found desirable, though it is not essential, for the two lamps to be physically configured into the curved shape shown in Figure 7. This configuration provides efficient illumination of the whole hot plate area with just two lamps.

In order to inhibit the formation of hot spots on the underside of the cooktop, the two lamps may be inclined towards one another so that, at their point of closest approach, they are at their greatest distance from the underside of the cooktop. They may be supported by suitable surface formation on the microporous material.

Alternatively, or in addition, a coating which partially reflects the IR radiation generated by the lamps may be applied on the upper part of the outer envelope of each lamp so as to inhibit direct upward transmission of the IR radiation from the lamps to the underside of the cooktop. The radiation so reflected is not wasted, however, because the configuration of the heating unit generally and the characteristics of heat retention and reflectivity of IR radiation exhibited by the microporous insulating material co-operate to constrain the radiation to the selected hot plate region of the cooktop.

Figure 8 shows, in schematic, cross-sectional view, a lamp, to the quartz envelope of which an upper coating 72 has been applied for the aforesaid purpose of inhibiting the direct transmission of IR radiation from the lamp to the underside of the cooktop. Preferably, though not necessarily, a lower

coating 73 is also applied to the lamp envelope as has been usual hitherto In this example, the upper coating 72 subtends an angle of 60°, and the lower coating 19 an angle of 120°, at the central axis of the lamp, and both coatings are symmetrical about the vertical plane containing the longitudinal, central axis of the lamp. None of these dimensions or conditions is critical, however, and they may be varied to produce desired results in any given unit configuration. Furthermore, either or both of the coatings 72 and 73 may be omitted from the vicinity of the ends of the lamp.

It will be appreciated that the upper coating 72 may, if desired, be replaced by a reflector disposed separate from the lamp and located between the lamps and the cooktop, though the use of a coating on the lamp itself is a convenient and preferred construction.

The lamps such as 66 are shown curved in Figure 7, and it will be appreciated that the degree of curvature employed is selected to accord with other dictates of any given embodiment. The curvature shown is thus illustrated purely by way of example.

Temperature control of the heating unit shown in Figure 7 is implemented by the control circuit shown in Figure 2 to provide the lamp configurations shown in Figure 3.

CLAIMS

1. Heating apparatus including a number of sources (1, 2) of infra-red radiation and a control circuit for providing a number of discrete power outputs of said sources (1, 2), and characterised in that said control circuit includes means (19) for switching power to said sources (1, 2) at a predetermined phase angle to achieve one or more of said power outputs.

2. Heating apparatus as claimed in Claim 1 wherein said sources (1, 2) of infra-red radiation each comprises an infra-red lamp (1) having a tungsten filament (3) supported within a quartz envelope (5).

3. Heating apparatus as claimed in Claim 2 wherein said control circuit is arranged to switch the lamp filaments (1) into series and/or parallel configurations to generate said power outputs.

4. Heating apparatus as claimed in Claim 3 wherein said control circuit is arranged to connect said means (19) for switching power to said sources (1, 2) at a predetermined phase angle into one or more of said configurations to achieve said one or more of said power outputs.

5. Heating apparatus as claimed in Claim 2, 3 and 4 wherein said control circuit comprises a dual control arrangement for energising one or more lamps (31, 32) located in an inner region (36) of said apparatus independently of one or more lamps (33, 34) located in a region peripheral of said inner region (36).

6. Heating apparatus as claimed in any one of claims 2 to 5 wherein said apparatus is arranged to be mounted beneath an infra-red-transmissive cooktop of a cooking hob so that said lamps (66) provide a hotplate area (8) of said cooktop, said lamps (66) being shaped into a curved configuration to provide efficient illumination over substantially the whole of said hotplate area (8).

7. Heating apparatus as claimed in Claim 6 wherein said lamps (66) are inclined, at least at their point of closest approach to each other, away from said cooktop.

8. Heating apparatus as claimed in Claim 6 or 7 wherein a coating (72), partially reflective of infra-red radiation generated by said lamps (66), is applied to a region of the envelopes of said lamps facing the underside of said cooktop.

9. Heating apparatus as claimed in Claim 6, 7 or 8 wherein an infra-red-reflective coating (73) is applied to a region of the envelopes of said lamps (66) on the opposing side to that facing the underside of said cooktop.

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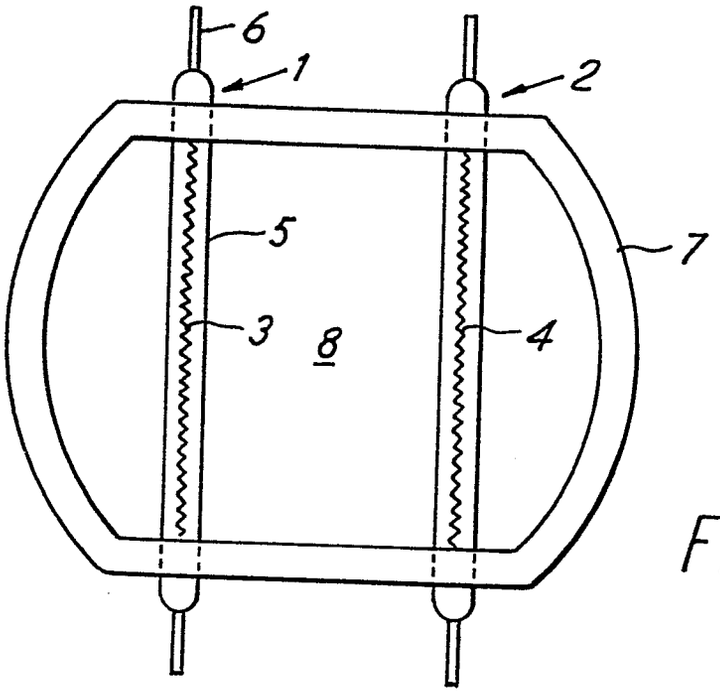


FIG.1

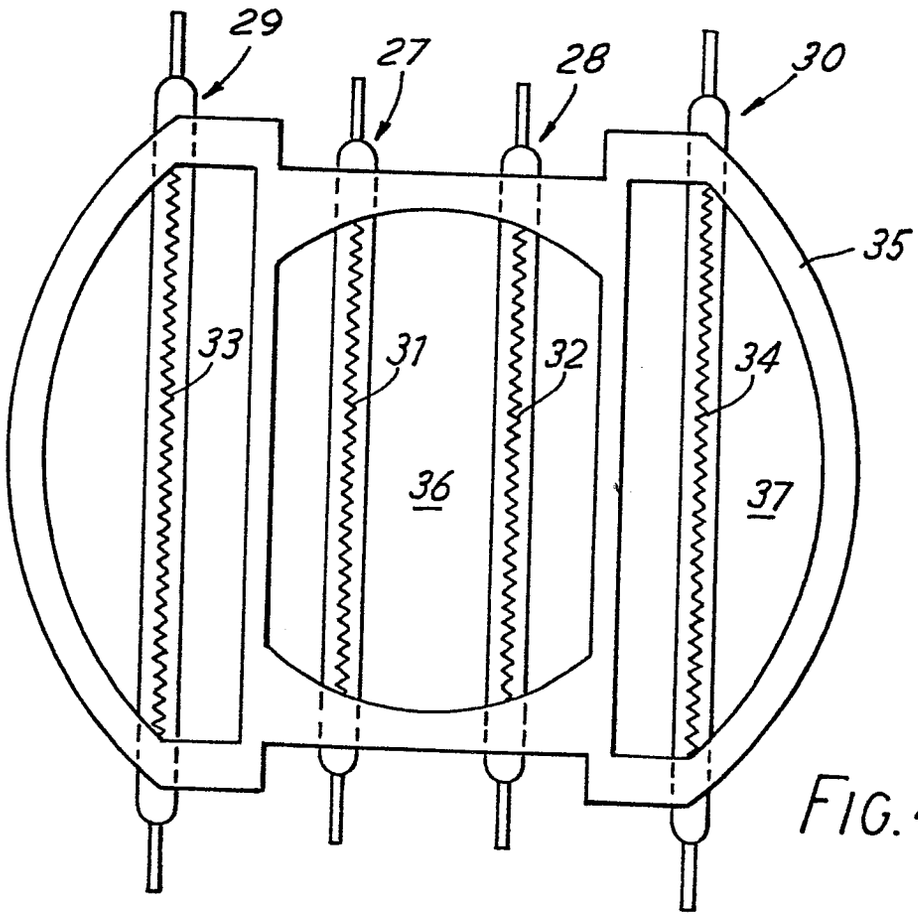


FIG.4

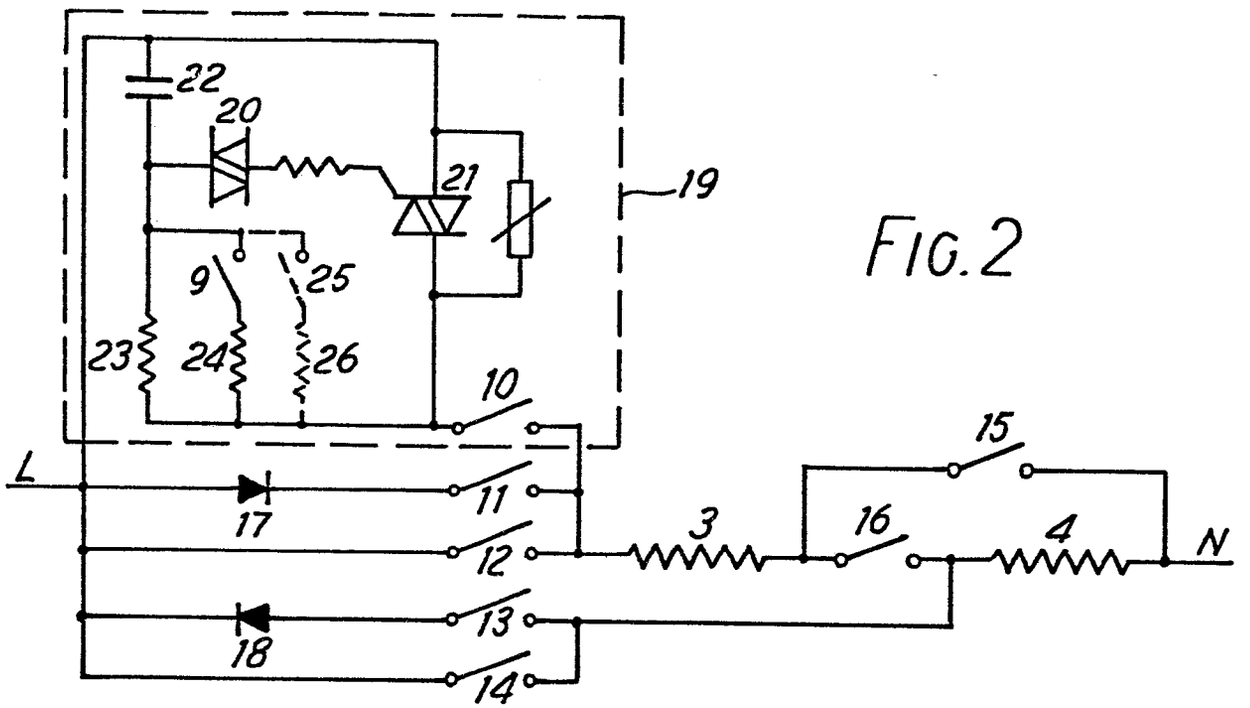
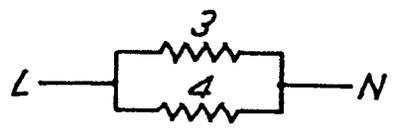
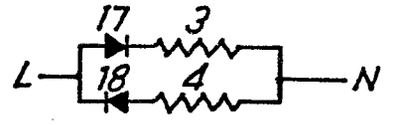
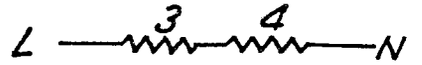
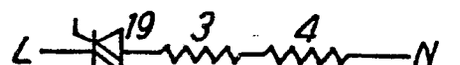
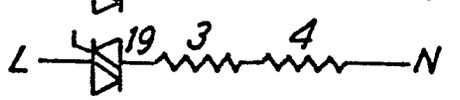


FIG. 2

FIG. 3

SETTING No.	SWITCHES CLOSED	POWER (W)	LAMP CONFIGURATION
6	12,14,15	1200	
5	11,13,15	690	
4	12,16	410	
3	11,16	220	
2	9,10,16	≈150	
1	10,16	≈110	
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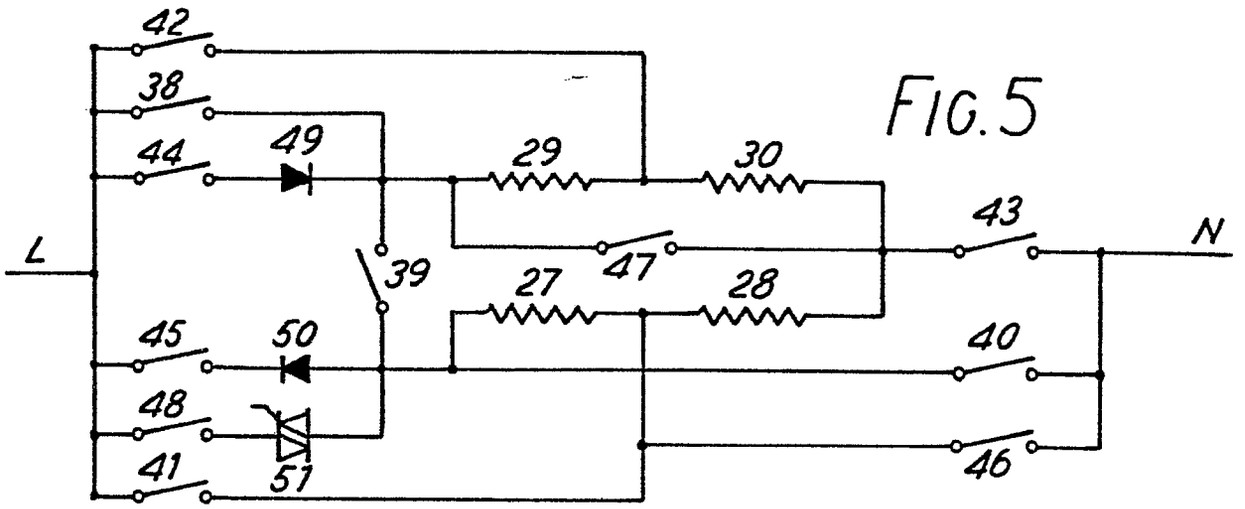
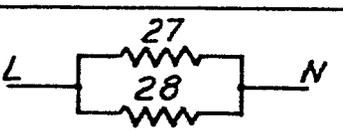
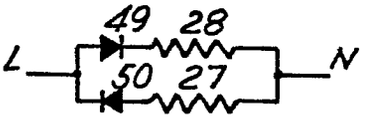
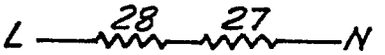
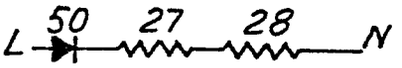
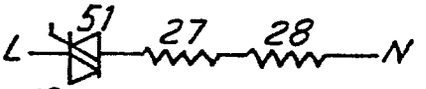
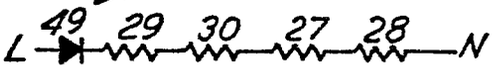
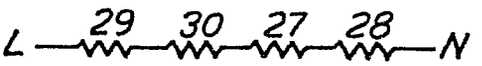
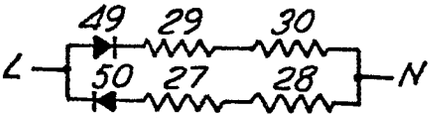
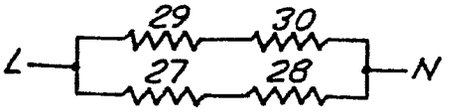
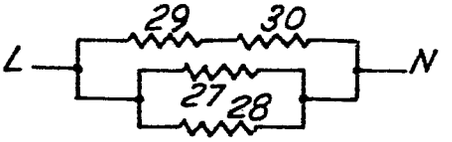
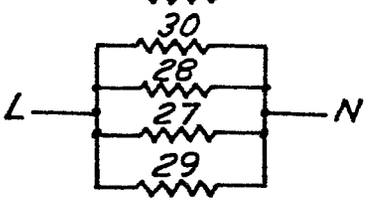


FIG.5

FIG.6

SETTING No.	SWITCHES CLOSED	POWER (W)	LAMP CONFIGURATION
5I	40,41,43	1000	
4I	44,45,46,47	575	
3I	38,40,47	340	
2I	43,45	187	
1I	43,48	116	
1D	40,44	130	
2D	38,40	240	
3D	43,44,45	440	
4D	38,39,43	730	
5D	38,40,41,43	1400	
6D	47,40,41,42,43	2200	
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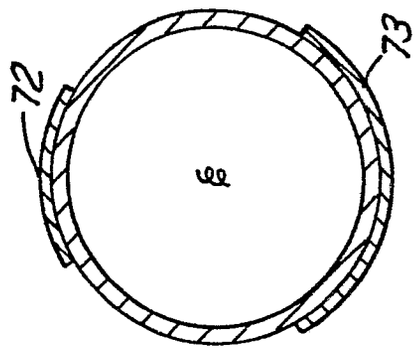

FIG.8

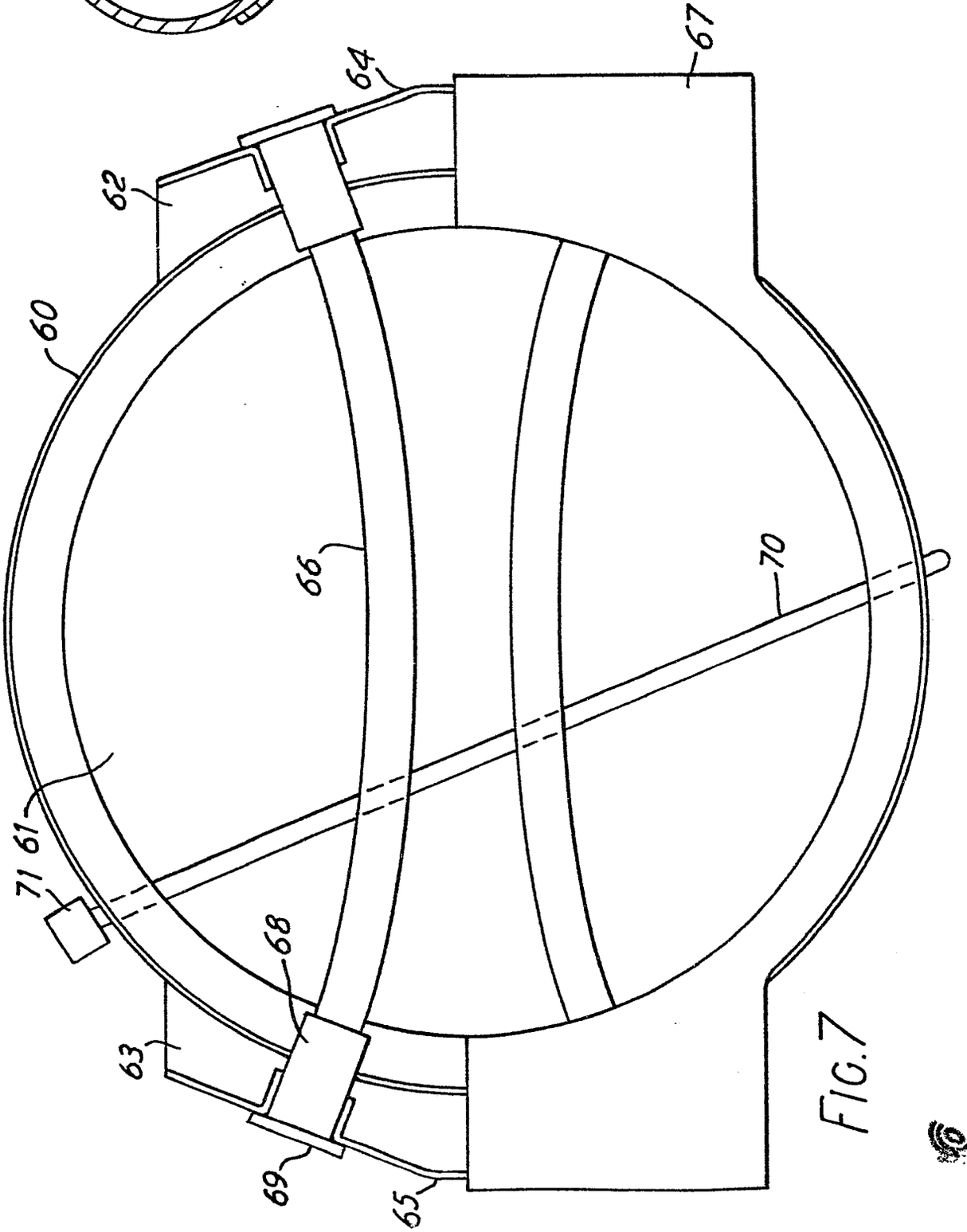

FIG.7

European Patent Office

EUROPEAN SEARCH REPORT

0174774
Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 85306107.5

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
D,A	GB - A - 2 132 060 (THORN) * Abstract; page 1, lines 76-104; page 1, line 127 - page 3, line 13; fig. 3,5 * --	1,2,3,4,6	H 05 B 3/74 H 05 B 3/68
A	US - A - 3 355 574 (A.T.BASSETT) * Column 2, line 60 - column 3, line 29; column 4, lines 15-26; fig. 2-4 * ----	1,2,6,9	

TECHNICAL FIELDS SEARCHED (Int. Cl 4)

H 05 B 3/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	29-11-1985	TSILIDIS

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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O : non-written disclosure
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